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# ***U.S. PATENT APPLICATION***

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***Invention:*** DEVICE AND METHOD FOR TRANSFER OF DATA PACKETS

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## ***SPECIFICATION***

Device and method for transfer of data packets

## TECHNICAL FIELD

- 5 The present invention relates to a transceiver device, a mobile terminal and a method, respectively, for mobile communication, according to the preamble of the appended claims 1, 10 respective claim 17.

## BACKGROUND ART

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Due to the health hazards concerning microwave radiation, the FCC rules for handheld devices, for example mobile terminals, such as mobile phones limits its power emissions to 2W. These rules may be further restricted if new rules will be adopted. The base station output power, however, is not  
15 restricted as strongly, as its radiating elements are not positioned in the vicinity of any human.

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There may be systems, e.g. the Mobitex system, configured such that the link budgets, i.e. the calculated losses withdrawn from the input power, on the uplink and downlink are highly unbalanced. Here, the term uplink refers to transmissions from the mobile terminal to the base station, and the term downlink refers to transmissions from the base station to the mobile terminal. The downlink may be up to 6 dB stronger than the uplink. In such a configuration there may be a border area at the edge of the cell, where the  
25 mobile terminal can hear the base station but has too low output power on the uplink in order to transmit a message to the network. This situation can result in a limited coverage and a misuse of the transmission capability. The resulting scenario can be that the mobile terminal wastes bandwidth by accessing the system and trying to transmit. Due to the unbalanced link  
30 budget, the message will not get through to the base, and bandwidth will be wasted on access collisions and re-transmissions. Also capacity of the downlink can be wasted if control messages, e.g. ACKs (ACKnowledgement,

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corresponds to the quality of said transfer. The measured value is then used to make decisions concerning said transfer. The transceiver device is characterized in that it includes rate changing means for changing the transfer rate of said data packet transfer depending on said decision

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The object is also accomplished by means of a mobile terminal of a kind mentioned in the preamble, with characterising features as disclosed in the appended claim 10, which is adapted for transfer of data packets to and from a transceiver device which comprises equipment for measuring a value which corresponds to the quality of said transfer, which measured value is used to make decisions concerning said transfer. The mobile terminal is characterized in that it is adapted for changing the transfer rate of said data packet transfer depending on said decision.

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The object is also accomplished by means of a method of a kind mentioned in the preamble, which characterising features are disclosed in the appended claim 17, which method discloses transfer of data packets between a first transceiver, and a second transceiver, said method comprising measuring, in said first transceiver, a value corresponding to the quality of said transfer.

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The invention is characterized in that it comprises comparing, in said first transceiver, said measured value with a predetermined threshold value, and adapting the transmission rate of said transmission depending on whether said measured value exceeds said threshold value.

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Preferable embodiments of the invention are disclosed in the appended dependent claims.

#### BRIEF DESCRIPTION OF DRAWINGS

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The invention will be described below in connection with an example of a preferred embodiment and the enclosed drawings, where

Figure 1 shows a simplified drawing of a mobile station and a user carrying a mobile terminal, such as a mobile phone;

5 Figure 2 shows a simplified drawing of a cellular grid, typical for mobile communication systems;

Figure 3 shows a principal sketch of the data packets for uplink communication;

10 Figure 4 shows a principal sketch of the data packets for downlink communication;

Figure 5 shows a flow chart for uplink communication; and

15 Figure 6 shows a flow chart for downlink communication.

#### MODES FOR CARRYING OUT THE INVENTION

20 This invention constitutes an improvement in the field of asymmetric wireless packet data networks. One such network is the so-called Mobitex network. With reference to Figures 1 and 2, the invention is applicable to the Mobitex network which is used in the further discussion as an example for illustration of the features, but the use of the invention is not restricted to the Mobitex network, but applicable to any asymmetric wireless packet data network, i.e.  
25 a wireless network where the uplink 1 and downlink 2 link budget is unbalanced in such a way that, for example, downlink transmissions are possible, but not uplink transmissions. This may be due to the different output powers for the uplink and downlink transmitters. This may be the case for any asymmetric mobile telephone (cellular phone) system or a mobile data  
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one. When the mobile terminal 4 moves into the coverage area of a new base station 3 and the new base station 3 provides a stronger RSSI-value (Receiver Signal Strength Information), the mobile terminal 4 sends a registering packet to the new base station 3 to register. All packets will then be routed via the new registered base station 3.

According to the prior art, the Mobitex radio link provides 8 kb/s data rate on both uplink 1 and downlink 2 to all users in a radio cell 6 on both the uplink 1 and the downlink 2. However, the sensitivity on the up- 1 and downlinks 3 may not be symmetric. Due to FCC rules for handheld devices, the power emission from a mobile terminal 4 is restricted to 2 W, and may be further restricted if new rules will be adopted. The base station's 1 power emission is not restricted as strongly. There may be systems configured such that the link budgets are highly unbalanced.

The downlink 2 may be up to 6 dB stronger than the uplink 1. In such a configuration there may be a border area at the edge 7 of the cell 6, where the mobile terminal 4 can hear the base station 3, but has too low output power on the uplink 1 to transmit a message to the network. This situation can result in a limited coverage and a misuse of the transmission capability. The resulting scenario can be that the mobile terminal 4 wastes bandwidth by accessing the system and trying to transmit. Due to the unbalanced link budget, the message will not get through to the base station 3, and bandwidth will be wasted on access collisions and re-transmissions. Also capacity of the downlink 2 can be wasted if control messages, e.g. ACKs (ACKnowledgement, ACK is a Mobitex radio frame), can not be sent from the mobile terminal 4.

On the other hand, there may be a major part of the cell 6 area where the downlink signal to noise ratio is higher than what is required to provide a reliable transmission. In these areas it is wasted transmit power capacity to use full power. The transmitted power then only creates more interference.

A new method, according to this invention, is designed to adapt the data rate on the radio channel according to said radio channel's link budget conditions for each mobile terminal 4. The method is called ADR (Adaptive Data Rate).

5 The method consists of two parts, an uplink 1 rate adaptation and a downlink 2 rate adaptation. In this example, the uplink 1 adaptation method will be called LDR (Low Data Rate) which for this specific embodiment example corresponds to 25% of default data rate, and the downlink 2 adaptation method will be called HDR (High Data Rate) which for this specific  
10 embodiment example corresponds to 600% of default data rate. It should be understood that these data rates only are stated as examples, and may be altered within the scope of the invention. Due to the asymmetric character of the up- 1 and downlink 2 channels, it is only the network side that has direct knowledge of the relation between up- 1 and downlink 2.

15 The base station 3 may transmit with a high power on the downlink 2 and the mobile terminal can not make any assumptions about the received signal strength from the base station 3 from measuring the downlink 2. According to the embodiment, the adaptation algorithm will be placed in the base station 3.

20 This also allows for flexible software updates of the procedure. The mobile terminal 4 measures the RSSI value on the downlink 2 and reports to the base station 3 in measurement reports. Based on mobile terminal reports, the base station adaptation algorithm makes an estimate of the channel and decides on what data rate to use when transmitting to the mobile terminal 4  
25 on the downlink 2.

For the uplink data rate adaptation, the base station algorithm makes a decision based on RSSI measurement in the base station 3 on transmissions from the mobile terminal 4. The decided uplink data rate is indicated to the  
30 mobile terminal 4 in a message sent back to the mobile terminal 4. The mobile terminal 4 then has to continue its transmission using the data rate that the base station 3 has decided upon. At any time it is possible for the



base station adaptation algorithm to change the chosen rate and indicate this to the mobile terminal 4. In this way retransmitted blocks can be sent using a lower data rate if so required.

- 5 Due to the fact that the link does not have a fixed time frame structure, it is possible to extend a transmission in time when doing a retransmission of a data block using a lower data rate. This means that it is possible to keep protocol message definitions and that data block sizes do not have to be changed depending on the transmission rate to fit into any fixed time slots.
- 10 Also, due to the independent nature of the up- and downlink adaptation algorithms, a situation may occur, where only one of the links is adapted, or even the situation where the adaptation is such that the uplink 1 is in low rate while the downlink 2 is in high rate. The detailed description of the algorithm is given below.

15 According to the new method for adapting data rate to the radio environment conditions described in this invention, the following procedures are executed in the Mobitex system for uplink 1 and downlink 2 transmissions:

20 A general uplink 1 transmission procedure will be described in the following with reference to Figure 3. The specific events in Figure 3 will be described in detail following the general procedure below.

25 1. A mobile terminal (MS) has registered on a radio packet data channel served by a base station . It has already performed a successful registering procedure and registered in the current base station. The mobile terminal monitors the system channel in order to receive packet notations. The mobile terminal also makes RSSI measurements of own and neighbor cells in order for making registering decisions.

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2. When the mobile terminal 4 has a data packet to transmit to the network, it must wait for a FRI 8 (Free, FRI is a Mobitex radio frame) signal

indicating the following access time slots. The base station 3 allocates an appropriate number of access timeslots at appropriate intervals according to the traffic situation. All of these access time slots can be used by both new LDR mobile terminals 4 and old ones. The base station 3 will be able to detect both types of mobile terminals 4 by doing parallel detection of the ABD (Access Request Data, ABD is a Mobitex radio frame) messages in LDR and in normal mode. This is accomplished by parallel detection of the message synch pattern, which indicates which mode that is used in the rest of the message.

3. The mobile terminal shall send an ABD message in an access slot and require uplink 1 transmission resources for the data packet. The data packet consists of a number of blocks up to a maximum size. A mobile terminal 4 using LDR always sends the ABD on the lower data rate; ABD-L 9. The ABD-L 9 shall include the latest measured RSSI-value for the current base station 3.

4. When the base station 3 receives an ABD-L 9, it checks the RSSI-value measured during the reception of the ABD-L 9. Using the two available RSSI-values (for uplink 1 and downlink 2) the base station 3 decides which data rate to use for the following data transfer. The normal operation for a base station 3 is to have a threshold value for the RSSI-value measured during the ABD-L 9. If the measured value exceeds the threshold the default data rate should be used, otherwise the lower data rate should be used.

5. The base station 3 schedules the mobile terminal 4 for transmission of the packet on the uplink 1 and sends an ATD 10 (Access Granted Data, ATD is a Mobitex radio frame) message to the mobile terminal 4, indicating to the mobile terminal 4 that it will get exclusive access to the channel and can start transmission. The ATD 10 includes information about which data rate to use for the transmission of the data packet, the MRM 11 (Message

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mobile terminal 4 sends MRM 11 using default data rate, but the base station 3 does not receive the MRM 11 properly, why the base station 3 sends a REB 13. The mobile terminal then sends a RES using LDR, i.e. RES-L 14.

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A general downlink transmission procedure will be described in the following with reference to Figure 4. The specific events in Figure 4 will be described in detail following the general procedure below.

- 10 1. A mobile terminal 4 (MS) has registered on a radio packet data channel served by a base station 3. It has already performed a successful registering procedure and registered in the current base station 3. The mobile terminal 4 monitors the system channel in order to receive packet notations. The mobile terminal 4 also makes RSSI measurements of own and neighbor cells 6 in order for making registering decisions.
- 15 2. When the base station 3 has a data packet to transmit to a mobile terminal 4, the base station 3 makes a choice of the data rate to use on the downlink 2. The base station 3 needs to know if the mobile terminal 4 is capable of HDR or not. This information has to be included in the subscriber information.
- 20 3. If the mobile terminal 4 is not capable of HDR, the packet is transmitted to the mobile terminal 4 in the usual way.
- 25 4. If the mobile terminal 4 is capable of HDR, the adaptation algorithm in the base station 3 needs to make a decision based on available information about the mobile terminal's 4 reception status, RSSI or other information. See Figure 4 and the following discussion of the possible ways for the adaptation algorithm to choose the correct data rate.
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- 5 5. The base station 3 transmits the data packet, the MRM 11, to the mobile terminal 4. In all MRM 11 using HDR (MRM-H 16) the primary block is transmitted without using HDR. In this primary block it is stated that the following blocks are transmitted using HDR. The advantage is that the same sync can be used as in default data rate and the vital primary block has a high probability to be received correctly. Alternatively, a flag in the sync shall be used to indicate HDR frames.
- 10 6. RSSI-measurements shall be performed during receptions of all MRM 11 by the mobile terminal 4. The result shall be included in the response of the MRM 11 (ACK 12, REB 13 or NACK).
- 15 7. If the RSSI level indicated by the mobile terminal 4 in the ACK 12 exceeds a defined threshold the base station shall use HDR for the next downlink packet.

Downlink 2 transmission scenarios will be described in the following.

- 20 To be able to exploit the HDR possibility, a timer has to be used in the base station. This timer (HDT) shall indicate if it still is suitable to use HDR for a downlink packet. The timer shall be set when a packet is sent using HDR. When a downlink 2 packet shall be sent to the mobile terminal 4 and the HDT has not expired, HDR shall be used and the HDT shall be restarted. The timer period is preferably, but not exclusively, about 10 seconds. This means
- 25 that if the timer has not expired when a new message is about to be sent, the same data rate is used as last time, as the possibility of a change of the radio environment conditions then is considered to be low.

- 30 When a downlink packet shall be set and the mobile is capable of HDR there are four cases, shown in figure 4 below, with reference letters A, B, C and D:

- A. The HDT is set and has not expired. The packet is sent using HDR, the packet is then labeled MRM-H 16, and acknowledged with SA 17 (Short Acknowledge, SA is a Mobitex radio frame).
- 5 B. No active HDT and a short packet. The packet is sent not using HDR, just an ordinary MRM 11, and acknowledged with SA 17.
- C. No active HDT and a long packet. An AKT 18 (Activity Request, AKT is a Mobitex radio frame) is sent from the base station 3. The mobile terminal 4 includes the measured RSSI value in the SA 17. If the SA 17 includes a good enough RSSI, the HDT is set and the packet is sent using HDR, and acknowledged with SA 17 as shown in Figure 4. Else the default rate is used.
- 10 D. The HDT is set and has not expired, why the packet is sent from the base station 3 using HDR. Normally, if the mobile terminal's 4 response of an MRM-H 16 is a REB 13, the RES is sent from the base station 3 using default data rate and acknowledged with SA 17, as shown in Figure 4.
- 15 The limit between short and long packet has to be defined (only important for implementation in the base station).
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The short ACK (SA 17 in figure 4) could be replaced with ACK-L using normal LDR coding or the same coding as the ABD-L.

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The up- 1 and downlink 2 procedures are also described in the flowcharts disclosed in Figure 5 and Figure 6 respectively. As shown in Figure 5, there is a flowchart describing the uplink 1:

- 30 19: First the base station schedules FRI slots and receives an ABD-L from a LDR capable mobile terminal 4.

5 21: The base station checks if the weighted RSSI exceeds a predetermined threshold. If the weighted RSSI exceeds a predetermined threshold,

10 or, if the weighted RSSI falls below a predetermined threshold,

24: Send indication (ATD or REB) to the mobile including information about  
15 which data rate to use for the transmission of the data packet (MRM or RES).

26: Are all blocks received correctly? If not, then

or, if all blocks are received correctly, then

29: END.

30: The base station 3 has a data packet to transmit to a mobile terminal 4.

5 32: choose default data rate, and stop HDT. Then continue as described at reference number 38.

10 33: the base station checks if the timer HDT is set and has not expired. If that is the case,

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35: determine if the packet is a short packet (shorter than a predefined threshold). If yes, continue as described at reference number 32. If the answer is no,

37: Then the base station 3 checks if the RSSI indicated in the response  
25 (ACK or REB) exceeds a predetermined threshold. If yes, continue as  
described at reference number 34. If no, continue as described at reference  
number 32.

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39: Then check if all blocks are received correctly as indicated by ACK or REB. If yes, then



40: END.

If no,

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41: then the base station 3 checks the subscriber information to see if the mobile terminal 4 is capable of HDR. If yes, continue as described at reference number 37. If no, continue as described at reference number 32.

10 In one embodiment of the present invention, more error-correcting codes are used when the data transmission rate is decreased. In the example described above this is the case when the data packet is sent from the mobile terminal 4 to the base station 3, i.e. the uplink 1, using LDR.

15 In one other embodiment of the present invention, the wireless packet data network is combined with a wire-bound network.

In the examples above, the data rate from the mobile terminal 4 to the base station 3 is default or low, and the data rate from the base station 3 to the mobile terminal 4 is default or high. The invention is not limited to these embodiments, but the data rate from the mobile terminal 4 to the base station 3 may be low, high or default. In the same manner, the data rate from the base station 3 to the mobile terminal 4 may be low, high or default.

25 Not only the data rates low, high and default may be used, but more levels for the data rate may be used in the invention.

The invention is not limited to what has been described above, but may be varied freely within the scope of the appended claims.

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